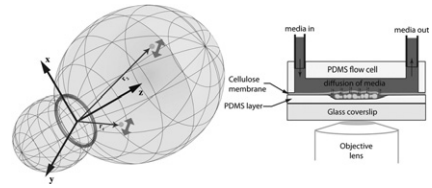
and experimentally. We show how the flexible body and the flexible hook connecting the helical flagellum and body may act together to generate the circular trajectories, and use modeling to show the range of curvatures allowed and compare this range to experiments. Finally, we discuss the implications of such circular trajectories in allowing monotrichous bacteria to undergo chemotaxis and interact with one another to aggregate.

1663-Pos Board B573
Effect of Nuclear Stiffness on Cell Translation In Vivo
Takamasa Harada, Dennis Discher.
Cell nucleus is the largest organelle and its stiffness is known to play an important role for cell migration in tissue. In this study, the effect of nuclear plasticity on cell translation is explored by controlling the cell stiffness by knocking down Lamin A/C, which is a major component of nuclear lamina, using RNA interference. After Lamin A/C is successfully down-regulated in A549 lung carcinoma cells, which are genetically modified to express far red fluorescent protein tdTomato, those cells are injected in NOD/SCID mice to investigate tumor progression and spreading of the cells in vivo by observation with Xenogen imaging system. Observation of tumor cell spreading in harvested tissues utilizing fluorescent microscopy is also done. This study qualitatively and quantitatively shows efficient spreading and proliferation of Lamin A/C down-regulated cells in comparison with control cells.

1664-Pos Board B574
Filament Depolymerization can Explain Chromosome Pulling During Bacterial Mitosis
Edward J. Banigan, Michael A. Gelbart, Zemer Gitai, Andrea J. Liu, Ned S. Wingreen.
Reliable chromosome segregation is crucial to all dividing cells, but the force-generating mechanisms underlying chromosome translocation in bacteria remain mysterious. Caulobacter crescentus utilizes a depolymerization-driven process in which a ParA protein structure grows from the new cell pole and binds to a ParB-decorated chromosome, and then retracts via disassembly, thus pulling the chromosome across the cell. This poses the question of how a depolymerizing structure can continuously and robustly exert forces as it is disassembled by the chromosome that it pulls. ParA binds to ParB, a protein that binds to the chromosome near the origin of replication (ori). ParB then disassembles ParA, and the ParB-decorated ori translocates across the cell as ParA retracts. In order to address the question of how depolymerization-driven motility can be sustained in steady-state and be robust to perturbations, we perform Brownian dynamics simulations of this system. We find that the interaction between ParB and ParA generates a steady-state ParA concentration gradient so that the concentration of ParA is higher in front of the chromosome than behind it. This suggests that the mechanism of translocation is "self-diffusiophoretic"; since the chromosome is attracted to ParA via ParB, it moves up the ParA concentration gradient, and thus across the cell. In addition, we find that the velocity of translocation is controlled by the product of a characteristic time scale for the chromosome to relax and the rate of disassembly of ParA. As long as this product is small compared to one, chromosome segregation is robust and proceeds at the speed of ParA disassembly. Our results provide a physical explanation of the mechanism of depolymerization-driven translocation in bacteria as well as predictions that can be tested by future experiments.

1665-Pos Board B575
Role of External Constraints on Single Cell Spreading on Microfabricated Substrates
Benoit Vianay, Jean-Jacques Meister.
Single cell spreading includes cell adhesion on extracellular matrix, mechanotransduction of external signal and cytoskeleton rearrangement. Involved in several crucial cellular processes like migration, differentiation or division, cell spreading is not a simple succession of events. Indeed, cellular elements involved during cell adhesion are also sensors that activate or inhibit signaling pathways. The actin cytoskeleton and adhesive site formations are continuously the results of protein assemblies and disassemblies influenced by signaling cross-talks. Integrins, the first signaling actor during adhesion, lead to the reorganization of the cell cytoskeleton and also the extra cellular matrix through actomyosin complexes which exert forces by contraction. The understanding of the whole spreading process remains difficult due to the complexity of the cellular response.
Micropatterning techniques are efficiently used to control and constraint cells spreading to specify and analyze their behaviors. The reproducibility of cytoskeleton and adhesive site organizations on micropatterned substrates reduces biological dispersion and allows to obtain statistical spatiotemporal measurements. Investigations on relevant cell adhesion actors through experimental measurements and modeling should point out links among them. The outcome of this work is to study relationships between cell spreading behaviors and extracellular matrix properties by monitoring precisely cytoskeleton and adhesive sites organizations.
We choose to simplify the cell environment by reducing the extracellular matrix to microfabricated substrates covered by a specified type of adhesive proteins. We thus apply two different external constraints: the geometry controlled by the adhesive pattern and the extracellular matrix biochemistry controlled by the type of protein functionalized on the substrate. Cell adhesion behaviors are therefore statistically quantified to study cellular mechanotransduction dependencies on controllable environmental conditions.

1666-Pos Board B576
Nonequilibrium Mechanics of the Mitotic Spindle Measured in Living Cells
Maria Kilfoil.
To carry out its life cycle and produce viable progeny through cell division, a cell must successfully coordinate and execute a number of complex nonequilibrium processes with high fidelity, in an environment dominated by thermal noise. One important example of such a process is the assembly of and maintenance of tension across the mitotic spindle, a nonequilibrium composite material including polymers and motor proteins that is responsible for organizing and separating the genetic material during cell division. The intrinsic microtubule dynamics and different motor proteins provide the forcing required for this dynamic process. We use high-resolution fluorescence confocal microscopy to observe and analyze the real space dynamics of the mitotic spindle in budding yeast and Drosophila melanogaster S2 cells. Centrosome trajectories are reconstructed from the three-dimensional fluorescence data and quantified in a coordinate system relevant to the cell division using specially-developed image analysis methods. The roles of specific motor proteins are isolated by altering their functionality through genetic and chemical means using a microfluidic device. We use the fluctuations in pre-anaphase centrosome positions to show how nonequilibrium motor activity controls the mechanical properties of an in vivo cytoskeletal network.



1667-Pos Board B577
Cell Edge Dynamics During Polarization
Mark E. Ambühl, Charles Brepsant, Jean-Jacques Meister, Ivo F. Sbalzarini, Alexander Verkhovsky.
Upon contact with a flat substrate, most eukaryotic cells first attach and spread radially, then break symmetry and start directed migration, a phenomenon known as polarization. We analyzed the dynamics of the cell edge during polarization using the model system of fish epidermal keratocytes, which exhibit consistent polarization and a simple, constant shape during migration. We have developed an automatic method based on a level set formalism to perform accurate cell edge segmentation from phase-contrast images and to obtain protrusion/retraction maps with high accuracy and resolution in space and time. Analysis of the resulting protrusion/retraction maps demonstrated that polarization was often preceded by a transient oscillatory state in which relatively large protruding regions were separated by retracting regions that traveled around the cell periphery as rotating ''blades'' or waves. Depending on cell size, three to five of these ''blades'' were observed per cell during the oscillatory phase. Convergence of the ''blades'' eventually led to a polarized state with only one blade (protrusion and retraction were hence segregated to opposite sides of the cell). We have extracted the parameters of the oscillations, such as wavelength, period, and propagation velocity, and characterized the dynamics of cell area, as well as perimeter and edge velocity during polarization. In order to investigate how the protrusion/retraction switch